Baseline Plant Community Monitoring Report,

Tallgrass Prairie National Preserve

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Background

The tallgrass prairie ecosystem once spread across more than 60 million hectares and extended from southern Texas to southern Manitoba (Collins and Glenn 1998). Now, however, it is estimated that as little as 1-4% (0.6-2.4 million ha) of the original tallgrass prairie remains (Weaver 1954). In addition to being highly fragmented and disparate, tallgrass prairie remnants tend to occur on sites of marginal agricultural use, usually steep slopes with rocky soils.

Historically, native tallgrass prairie was characterized by heterogeneity. The interaction of fire, grazing and climate formed a landscape in which few patches were burned or grazed at the same time every year (Hiebert 1998). It is estimated, using time until tree invasion under fire suppression, that historic grassland fire return intervals ranged from 3 to 5 years (Collins and Glenn 1995). In general, fires were relatively small in size (GMP 2000) and with seasonal variability (Bragg 1995). Variability in fire frequency and size led to spatially variable grazing as native ungulates preferentially grazed newly burned patches. Non-grazing behaviors, such as wallowing, also increased landscape heterogeneity (Plumb and Dodd 1993). The interaction of fire, grazing and climate affect ground flora composition and abundance in any given year (Hartnett *et al.* 1996, Albertson *et al.* 1957). The complexity of native tallgrass ecosystems often makes them difficult communities to manage, but also allows for potential high biodiversity.

Tallgrass Prairie National Preserve (TAPR) is the first National Park Service area established specifically for the preservation, protection and interpretation of the tallgrass prairie ecosystem (Hiebert 1998). Formerly known as the Spring Hill Ranch area and continuously grazed for cattle production for over 120 years, TAPR is over 9,000 acres of unplowed tallgrass prairie in the Flint Hills physiognomic province of Kansas. Land management of TAPR, under the current grazing lease, calls for early intensive stocking (EIS) of cattle and annual spring burning. This management does not fully simulate the temporal or spatial variability characteristic of a native tallgrass ecosystem, particularly the seasonality and behavior of fire. The approved TAPR General Management Plan (GMP) calls for a shift to a heterogeneous disturbance regime of fire and grazing to allow for more spatial and temporal variation. Starting in 2001, initial changes were made to decrease fire frequency and implement EIS with lighter stocking rates in the two southern pastures (Redhouse and Crusher, Table 1). However, Redhouse did receive higher than prescribed stocking in 2002 (Table 1), while Gashouse received less than prescribed stocking (though still more than Redhouse and Crusher) for 2001, 2002 and 2003.

Methods

The Prairie Cluster & Heartland Inventory and Monitoring Network (HTLN) implemented monitoring at TAPR in 2000 to provide analysis of baseline conditions and to assess future change in floral communities (see Willson *et al.* 2002 for detailed information on monitoring protocol). A total of 49 sample sites were established during the 2000-2001 period throughout four pastures at TAPR (Fig. 1). Current analysis is focused on 18 core plots that have been monitored for the last two years (2002-2003),

encompassing the major soils and corresponding plant communities on TAPR. The years of 2000-2001 were primarily focused on establishment of permanent sample sites and the small amount of data from these years was not a focus for analysis. Secondary plots were also established to encompass the range of soils present at TAPR, but are sampled less frequently. A smaller set of data is available ranging back to 1997 for the northern two pastures (Gashouse and Windmill) (Eddy 1999), which is useful for comparison of long-term trends in species groups. Data are collected each year in two sampling trips, one in late spring and one in early fall. In this way, accurate cover estimates and identification of warm season grasses and summer/fall flowering forbs can occur.

The PC-LTEM sampling design, based on the design of the Konza Prairie Long-Term Ecological Research Program, consists of randomly located, permanent, paired transects 50 meters in length and 20 meters apart with five circular $10m^2$ plots systematically spaced along each transect (Fig. 2). Each $10m^2$ plot also includes nested subplots of $1m^2$, $0.1m^2$ and $0.01m^2$ for more accurate frequency estimates. Working systematically from the smallest subplot ($0.01m^2$) to the largest ($10m^2$), all species are identified and foliar cover is estimated.

Given the complexity of ecological drivers in the prairie ecosystem, community composition at TAPR is assessed with several metrics. Measuring foliar cover of species, calculating species frequency, richness, diversity and the exotic/native ratio are among the means used to assess community composition.

As well as analysis of individual species, plants guilds are also assessed at TAPR. Often the use of plant guilds can be a helpful analytical tool for understanding ecological patterns and processes. Generally, plant guilds are classified by shared features, such as structural morphology, photosynthetic processes, drought tolerance, and the presence of woody tissue. These features are thought to reflect differences in how resources such as light, water and nutrients are obtained. Guilds simplify the array of species into groups making ecosystem processes and functions more easily understood (Kindscher 1994). The use of plant guilds can also compensate for errors related to field sampling identification.

Another species classification that can be useful in analysis is species response to management. John Weaver (1954) observed that prairie species respond differently to grazing and created the use of the terms “increasers and decreasers” based on the observation. Decreasers are those species that are more palatable to cattle and/or are affected by the physical presence of large ungulates and decline in abundance and size under grazing pressure. Conversely, increasers are non-palatable prairie species which increase in abundance and size under intense grazing pressure due to such factors as decreased competition or change in physical environment. An abundance of an increaser species could indicate possible overgrazing in the tallgrass prairie. Conversely, an abundance of decreasers could indicate overall “good” health of a prairie. This classification allows for a quick qualitative analysis of whether the prairie is in good condition or not (Fraser and Kindscher 1997). Frequency and cover of 14 increaser

species and 13 decreaser species was analyzed over the baseline period of 2002-2003 at TAPR.

Analyzing patterns in species richness at the sample site and preserve-wide scale allows calculation of three kinds of diversity for TAPR (Whittaker 1972). Alpha diversity, local level diversity, is calculated as the average species richness per sample site, while gamma diversity, landscape level diversity, is estimated as the total number of species across all sample sites (McCune and Mefford 1997). Beta diversity, as a measure of the heterogeneity in the data, is calculated as (Whittaker 1972):

$\beta_w = (S_c / S) - 1$

where:
β_w = beta diversity,
S_c = the number of species in the composite sample,
S = the average species richness in the sample units.

As a rule of thumb, values of $\beta_w < 1$ are rather low and $\beta_w > 5$ are considered high beta diversity (McCune and Grace 2002). If $\beta_w = 0$, then all sample units have all of the species. The one is subtracted to make zero beta diversity correspond to zero variation in species presence. While this measure does not have any formal units, the result can be thought of in approximate units as the "number of distinct communities" (McCune and Grace 2002).

Results

Baseline Conditions:

Over the 2002-2003 sample period, 158 unique species were found on HTLN sample sites at TAPR including 40 families. Annual richness (gamma diversity) ranged from 130 to 147 species with few exotics (Tables 2a & 2b). On average, 57 species were found per sample unit (alpha diversity) resulting in an average, preserve-wide measure of beta diversity of 1.43. Warm season grasses such as indiangrass (*Sorghastrum nutans* (L.) Nash) and big bluestem (*Andropogon gerardii* Vitman) are the major components of the flora, ranging from 53 to 75% of the floral coverage within a sample site depending on the year (Tables 2c & 2d). Less significant but still prominent components of the flora at TAPR include cool-season grasses such as Junegrass (*Koeleria macrantha* (Ledeb.) J.A. Schultes) and buffalo grass (*Buchloe dactyloides* (Nutt.) Englem.), grass-like species of sedges and rushes, woody species including dwarf prairie rose (*Rosa arkansana* Porter) and smooth sumac (*Rhus glabra* L.), showy spring forbs such as butterfly milkweed (*Asclepias tuberosa* L.), 26 species of summer and fall flowering forbs, 15 species of legumes and two cacti.

Most species guilds showed little inter-annual variation between 2002 to 2003 (Tables 2c & 2d). However, two species guilds did show significant differences between 2002 and

2003. The annuals and biennials showed significantly higher frequency and cover in 2003 than 2002, while warm season grasses had lower cover in 2003 than 2002.

Exotics, most notably Kentucky bluegrass (*Poa pratensis* L.) and redseed plantain (*Plantago rhodosperma* Dcne.), comprise only a small component of the vegetation at TAPR (Table 3a). Dominant species (i.e. those with high importance values) include native species such as big bluestem, little bluestem (*Schizachyrium scoparium* (Michx.) Nash), side-oats grass-grass (*Bouteloua curtipendula* (Michx.) Torr.) and lead plant (*Amorpha canescens* Pursh) (Table 3b) (see Appendix A for full species list). As expected, grass and grass-like species dominated the community structure with 46% of the mean cover, with very little shrub cover (4%) (Table 4a). Unvegetated ground was predominantly bare soil (59%) with some grass litter (32%) (Table 4b).

As a qualitative measure of prairie health, the frequency and abundance of increaser and decreaser species, as defined by Fraser and Kindscher (1997) was inconclusive. Certain forb species commonly associated with heavy grazing (i.e.western ironweed, *Vernonia baldwinii* Torr. and white heath aster, *Symphyotrichum ericoides* (L.) Nesom) occur at conspicuously high frequency in the prairie. On the other hand, other species classified as increasers such as clammy ground cherry (*Physalis heterophylla* Nees) and hoary verbena (*Verbena stricta* Vent.) are present only negligibly (Table 5).

Preliminary Trend Detection:

Given differences in sample effort since 1997 and the evolution of taxonomic knowledge, it is not yet possible to definitively comment on trends in the effect of management activity at TAPR since 1997. However, it is possible to comment on general trends in abundance of groups of species, as these are less affected by sampling error. Since 1997, cover of warm season grasses has varied significantly year to year, perhaps due to weather (Fig. 3). Meanwhile, cool-season grasses have shown a steady increase (Fig. 3), while annuals/biennials had high abundance in 2001 and 2003. The annual species broomweed (*Amphiachyris dracunculoides* (DC.) Nutt.) was seen in vast abundance in both 2001 and 2003 (Fig. 4).

Preliminary Comparison of Management Regimes:

With preliminary changes to fire return interval and stocking rates, there is little difference between pastures for the metrics measured. Preliminary results indicate that Redhouse, with reduced fire and stocking, had a slightly greater increase in annuals and biennials in 2003 than Windmill, but less of an increase in summer forbs than Windmill and Crusher (Fig. 5). Research at Konza Prairie LTER Program also found increased forb cover with increased fire frequency in grazed prairie (Knapp *et al.* 1998). It may be too early to see significant changes in plant guilds between pastures from these initial changes in fire frequency of Crusher and Redhouse pastures. The pastures with reduced fire and stocking showed decreases in beta diversity from 2002 to 2003, as did Windmill pasture (Table 6). Gashouse was the only pasture to show increased beta diversity.

Discussion

Early intensive grazing and annual spring burning, implemented in the last 20+ years, has had an overall homogenizing effect on the landscape. This is reflected by the low beta diversity seen preserve-wide. Alternate management, such as reduced stocking and a variable fire regime, may increase beta diversity. So far, the minor modifications to the stocking rate (except Windmill pasture) and the fire frequency (Redhouse and Crusher pastures only) have not improved heterogeneity across the preserve.

While possibly increasing landscape heterogeneity, longer fire return intervals can also allow for more annuals/biennials to become established, as well as allowing for increases in invasive and exotic species previously controlled by frequent fire. While annuals and biennials have increased at TAPR, especially in Redhouse, exotics are still relatively absent. As heterogeneity of fire and grazing increases at TAPR, existing exotics could increase in frequency or abundance. Additionally, while the use of grazing indicator species (Fraser and Kindscher 1997) was inconclusive as a means of quickly assessing the health of the prairie, increasers and decreasers will continue to be monitored in the future as management changes.

In addition to grazing and fire, climatic variability is the third important factor driving dynamics at TAPR, with species responding to variability in annual precipitation. Precipitation in 2003 is the first since 1999 to be above the 30-year average (Fig. 6). Increases in annuals/biennials occurred in 2001 and 2003, most notably broomweed. Towne and Owensby (1983) found that increased bare ground resulting from drought, grazing, fire and mowing significantly increased the amount of broomweed in the Kansas Flint Hills. At TAPR, significant increases in broomweed occurred preserve-wide without regard to management regimes. Photopoint interpretation has also captured a negative effect of low precipitation levels on perennial forbs at TAPR (Barnard 2003).

It is still too early to determine the effects of changes in cattle stocking and fire frequencies on the warm season grass component of TAPR. Year-to-year and within-year changes in abundance make short-term detection of management effects on warm season grasses difficult. Future work, including better estimates of frequency for warm season grasses through ancillary sampling, will likely increase knowledge of changes in abundance of plant guilds and the effects of change in management regimes. Future monitoring results when compared to the baseline period should provide a good measure of future management.

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Table 1 Years of prescribed burning in four pastures at TAPR. Asterisks (*) indicate years of reduced stocking. Redhouse received higher than prescribed stocking for 2002, while Gashouse received lower than prescribed stocking (though still more than Redhouse and Crusher) for 2001, 2002 and 2003.

Pasture	1997	1998	1999	2000	2001	2002	2003
Windmill	X	X	X	X	X	X	X
Gashouse	X	X	X	X	X	X	X
Redhouse	X	X	X		*	X	*
Crusher	X	X	X	X	X*	*	X*

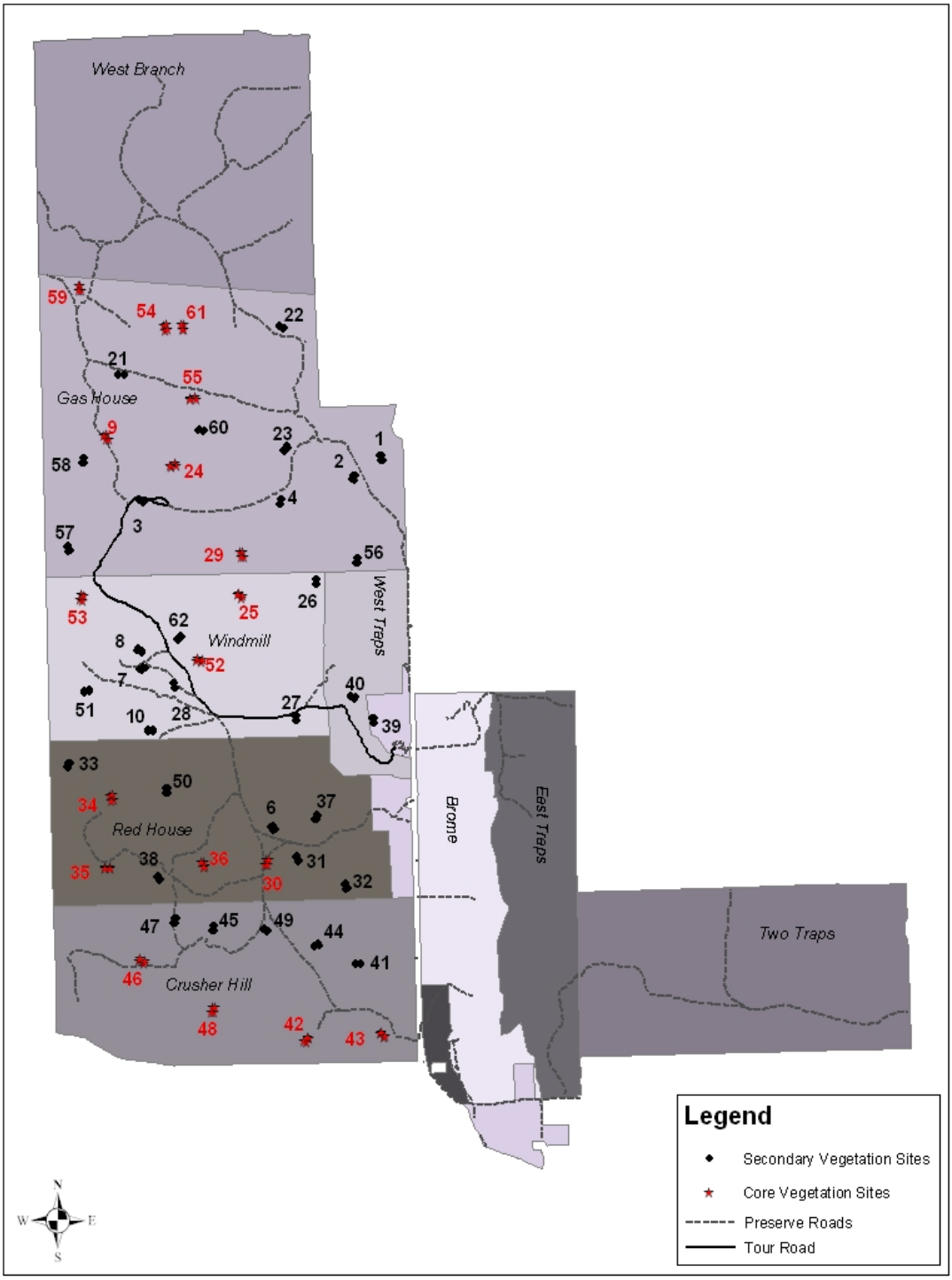

Figure 1 Map of TAPR showing pastures and PC-LTEM core and secondary sites.

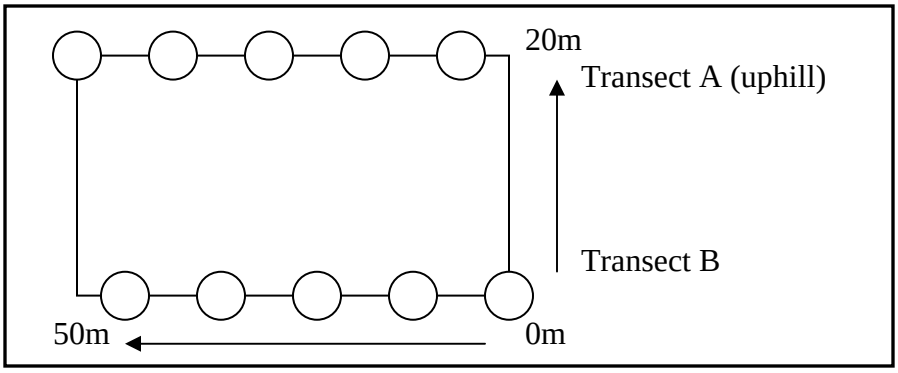

Figure 2 PC-LTEM sampling design with paired 50m long transects and 10 systematically placed 10m2 plots for sampling ground flora vegetation.

Table 2a Plant community compositions: species richness and shannon diversity.

All Species:	2002	2003	2-yr Avg. (st dev)
Richness	130	147	**138.5** (12.02)
Total Diversity	2.71	3.27	**2.99** (0.40)
Mean Diversity (st dev)	2.39 (0.35)	2.88 (0.25)	**2.64** (0.35)
Total Evenness	0.56	0.66	**0.61** (0.07)
Mean Evenness (st dev)	0.61 (0.08)	0.7 (0.05)	**0.66** (0.06)
Native Species Only:	2002	2003	2-yr Avg. (st dev)
Richness	124	135	**129.5** (7.78)
Total Diversity	2.7	3.23	**2.97** (0.37)
Mean Diversity (st dev)	2.38	2.86	**2.62** (0.34)
Total Evenness	0.56	0.66	**0.61** (0.07)
Mean Evenness (st dev)	2.38	2.86	**2.62** (0.34)

Table 2b Plant community composition: relative frequency and cover of exotic species.

Species richness	2002	2003	2-yr Avg. (st dev)
Exotic Species	5	10	**7.5** (3.54)
Native Species	124	135	**129.5** (7.78)
Ratio E/(E+N)	0.039	0.069	**0.054** (0.02)
	2002	2003	2-yr Avg. (st dev)
Exotic Species:			
Relative Frequency	0.79%	2.10%	**1.45%** (0.93)
Relative Cover	0.21%	0.88%	**0.55%** (0.47)
Native Species:			
Relative Frequency	99.21%	97.90%	**98.55%** (0.93)
Relative Cover	99.79%	99.12%	**99.45%** (0.47)

Table 2c Plant community composition: relative cover of native plant guilds.

Plant Guild	2002	2003	2-yr Avg. (st dev)
Annuals/Biennials	0.87%	11.21%	**6.04%** (7.31)
Cool Season Grasses	5.15%	8.30%	**6.73%** (2.23)
Ephemeral Spring Forbs	1.48%	1.69%	**1.59%** (0.15)
Grass-like	1.37%	1.97%	**1.67%** (0.42)
Legumes	1.42%	2.99%	**2.21%** (1.11)
Spring Forbs	2.59%	3.35%	**2.97%** (0.54)
Succulents	0.05%	0.09%	**0.07%** (0.03)
Summer/Fall Forbs	5.89%	12.57%	**9.23%** (4.72)
Warm Season Grasses	75.27%	52.50%	**63.89%** (16.1)
Woody Shrubs and Vines	5.77%	5.06%	**5.42%** (0.50)

Table 2d Plant community composition: relative frequency of native plant guilds.

Plant Guild	2002	2003	2-yr Avg. (st dev)
Annuals/Biennials	3.30%	14.28%	**8.79%** (7.76)
Cool Season Grasses	10.45%	8.79%	**9.62%** (1.17)
Ephemeral Spring Forbs	6.94%	6.16%	**6.55%** (0.55)
Grass-like	4.85%	3.63%	**4.24%** (0.86)
Legumes	6.47%	7.06%	**6.77%** (0.42)
Spring Forbs	9.85%	9.42%	**9.64%** (0.3)
Succulents	0.26%	0.19%	**0.23%** (0.05)
Summer/Fall Forbs	21.51%	20.41%	**20.96%** (0.78)
Warm Season Grasses	31.73%	26.11%	**28.92%** (3.97)
Woody Shrubs and Vines	4.05%	3.40%	**3.725%** (0.46)

Table 3a Plant community composition: exotic species.

Species	Common Name	Frequency	Mean Cover	Importance Value (st dev)
Plantago rhodosperma	Plantain	22.50%	0.52%	0.00425 (0.00272)
Poa pratensis	Kentucky bluegrass	14.17%	1.34%	0.00385 (0.00039)
Digitaria ischaemum	Smooth crabgrass	1.95%	0.43%	0.00055 (0.00039)
Veronica arvensis	Corn speedwell	1.95%	0.25%	0.00035 (0.00025)
Stellaria media	Common chickweed	1.67%	0.46%	0.00035 (0.00025)
Lactuca serriola	Prickly lettuce	1.11%	0.25%	0.0002 (0.00014)
Lepidium campestre	Field-cress	0.56%	0.25%	0.0001 (0.00007)
Thlaspi arvense	Field penny-cress	0.56%	0.25%	0.0001 (0.00007)
Capsella bursa-pastoris	Shepherd's purse	0.56%	0.50%	0.0001 (0.00)
Setaria viridis	Green foxtail-grass	0.28%	0.25%	0.00005 (0.00004)
Rumex crispus	Curly dock	0.28%	0.25%	0.00005 (0.00004)
Arenaria serpyllifolia	Thyme leaf sandwort	0.28%	0.25%	0.00005 (.000004)

Table 3b Plant community composition: herbaceous and shrub species with an importance value greater than 0.02 (all species listed in appendix D).

Species	Common Name	Frequency	Mean Cover	Importance Value (st dev)
Andropogon gerardii	Big bluestem	99.44%	15.25%	0.1336 (0.0371)
Schizachyrium scoparium	Little bluestem	99.72%	7.34%	0.07535 (0.0303)
Bouteloua curtipendula	Side-oats grama-grass	98.06%	7.37%	0.07535 (0.0139)
Amorpha canescens	Lead-plant	98.06%	3.51%	0.0445 (0.0051)
Buchloe dactyloides	Buffalograss	67.50%	4.51%	0.0362 (0.0116)
Panicum virgatum	Switchgrass	89.45%	2.62%	0.03435 (0.01)
Bouteloua hirsuta	Hairy grama-grass	58.61%	4.23%	0.0302 (0.0106)
Sorgastrum nutans	Indian grass	93.06%	1.78%	0.02985 (0.011)
Sporobolus asper	Tall dropseed	93.61%	1.83%	0.0298 (0.0016)
Amphiachyris dracunculoides	Broomweed	43.34%	3.30%	0.0265 (0.0368)
Symphyotrichum ericoides	Squarrose white wild aster	84.72%	1.52%	0.0256 (0.0078)
Carex spp.	Sedges	97.22%	0.10%	0.0251 (0.00)
Ambrosia psilostachya	Western ragweed	90.28%	1.08%	0.02375 (0.005)
Eragrostis spectabilis	Purple lovegrass	93.61%	0.83%	0.0231 (0.0023)
Vernonia baldwinii	Western ironweed	76.95%	1.37%	0.0225 (0.0035)
Bouteloua gracilis	Blue grama	36.39%	5.69%	0.02125 (0.0043)
Dichanthelium spp.	Panic grasses	92.22%	0.59%	0.02115 (0.0036)

Table 4a Plant community structure: shrub and herbaceous cover.

	Mean Percent Cover		
Plant Type	2002	2003	2-yr Avg. (st dev)
Grasses/Grass-Like	52.85	40.09	**46.47** (9.02)
Herbs	7.47	20.05	**13.76** (8.90)
Shrubs	4.1	3.49	**3.8** (0.43)

Table 4b Plant community structure: ground cover.

	Mean Percent Cover		
Structural Component	2002	2003	2-yr Avg. (st dev)
Bare Soil	59.11	58.1	**58.61** (0.71)
Bare Rock	9.24	11.61	**10.43** (1.68)
Grass Litter	37.72	26.94	**32.33** (7.62)
Woody Debris	0.04	0.07	**0.055** (0.02)
Leaf Litter	0.04	0.07	**0.055** (0.02)
Unvegetated Surface	86.81	86.04	**86.43** (0.54)

Table 5 Average frequency and cover of plant species classified by Fraser and Kindscher (1997) as increasing or decreasing with intensive grazing pressure.

Scientific Name	Common Name	Grazing Class	Average Plot Frequency (%)		Average Cover (%)	
			2002	2003	2002	2003
Amorpha canescens	leadplant	decreaser	97.78	98.33	3.85	3.16
Andropogon gerardii	big bluestem	decreaser	99.44	99.44	18.81	11.67
Aster sericeus	western silvery wild aster	decreaser	7.22	8.33	0.11	0.15
Astragalus crassicarpus	ground plum, prairie plum	decreaser	5.00	10.56	0.14	0.28
Comandra umbellata	bastard toad-flax	decreaser	0.56	0.56	0.03	0.03
Dalea candida	white prairie clover	decreaser	1.67	3.33	0.08	0.11
Dalea purpurea	purple prairie clover	decreaser	46.11	47.22	0.42	0.36
Elymus canadensis	Canada wild rye	decreaser	3.33	5.00	0.11	0.11
Panicum virgatum	switchgrass	decreaser	83.33	95.56	1.58	3.33
Psoralea esculenta	breadroot scurf-pea	decreaser	7.78	18.33	0.19	0.33
Rosa arkansana	dwarf prairie rose	decreaser	1.67	1.67	0.06	0.06
Sisyrinchium campestre	blue-eyed grass	decreaser	25.56	32.78	0.39	0.47
Viola pedatifida	prairie violet	decreaser	22.78	21.67	0.28	0.28
Achillea millefolium	common yarrow	increaser	28.33	28.89	0.47	0.42
Antennaria neglecta	field pussytoes	increaser	22.22	26.67	0.50	0.65
Artemisia ludoviciana	white sage	increaser	37.78	33.89	0.75	0.71
Asclepia verticillata	whorled milkweed	increaser	13.89	16.11	0.31	0.31
Symphyotrichum ericoides	white heath aster	increaser	82.22	87.22	0.57	2.30
Baptisia bracteata v. leucophaea	plains wild indigo	increaser	6.67	13.89	0.24	0.97
Buchloe dactyloides	buffalograss	increaser	61.11	73.89	2.66	4.90
Eragrostis spectabilis	purple lovegrass	increaser	92.78	94.44	0.83	0.81
Erigeron strigosus	rough fleabane	increaser	7.22	1.67	0.08	0.08
Physalis heterophylla	clammy ground cherry	increaser	0.00	1.11	0.00	0.06
Poa pratensis	Kentucky bluegrass	increaser	12.78	15.56	0.21	0.45
Solidago missouriensis	Missouri goldenrod	increaser	9.44	45.00	0.31	0.52
Verbena stricta	hoary verbena	increaser	7.78	9.44	0.17	0.22
Vernonia baldwinii	western ironweed	increaser	75.56	78.33	0.79	1.75

Figure 3 Average guild abundance over entire sampling period at TAPR for northern two pastures (Windmill and Gashouse).

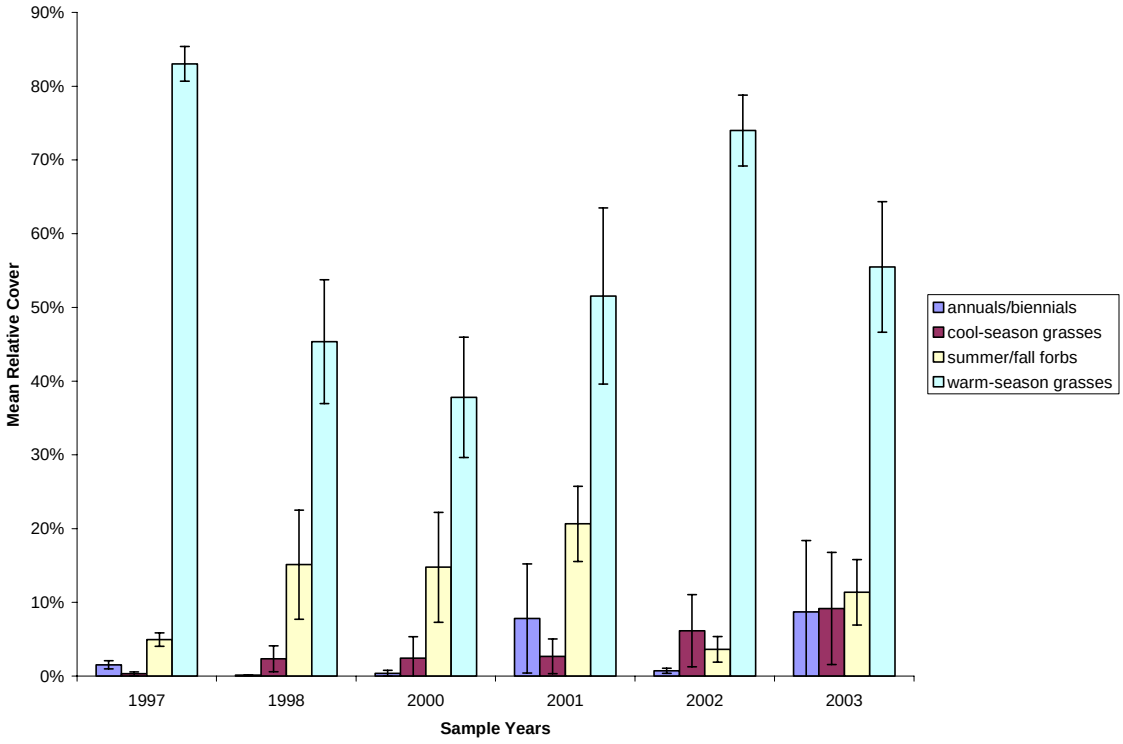

Figure 4 October 2003 landscape at TAPR showing yellow patches of broomweed, *Amphiachyris dracunculoides* (DC.) Nutt.

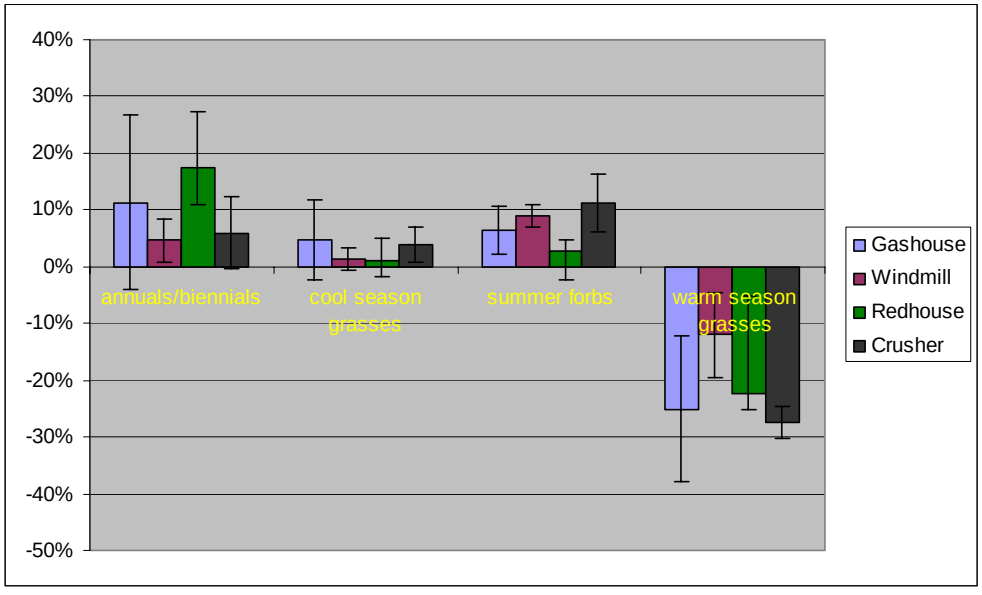

Figure 5 Percent change in abundance of plant guilds for each pasture 2002 to 2003.

Table 6 Three levels of diversity for entire TAPR preserve, as well as four pastures for baselines years of 2002 and 2003.

TAPR Area of Interest	N	alpha		beta		gamma	
		2002	2003	2002	2003	2002	2003
Preserve	18	51.9	62.2	1.5	1.36	130	147
Gashouse	7	49.6	61.9	0.75	0.97	87	122
Windmill	3	60	62.3	1.53	1.43	92	89
Redhouse	4	53.2	63.2	1.71	1.61	91	102
Crusher	4	48.5	61.5	1.79	1.77	87	109

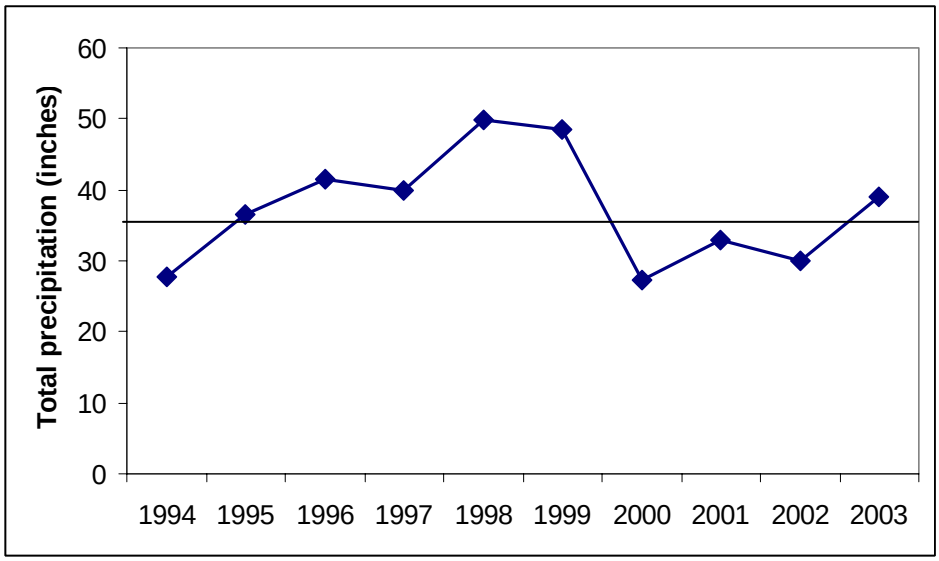

Figure 6 Thirty year averages for precipitation at TAPR 1994 to 2003. (Weather data acquired from Missouri State Climatologist for weather station ID 148061 located at TAPR.)

Appendix A: Species list for Tallgrass Prairie National Preserve including years 1997 to 2003.

Guilds: **annual-biennial** = opportunistic herbaceous species that complete life cycle in one or two years; **coolgrass** = cool season grass, members of Poaceae, initiate flowering prior to July; **ephemeral** = herbaceous spring forbs characterized by short flowering period in spring (typically in late March or April), foliage dries up by early summer; **grass-like** = species which resemble grasses in their growth form and morphology, terrestrial members of Juncaceae and Cyperaceae; **legume** = members of Fabaceae, capable of fixing nitrogen through root nodules; **spring forb** = herbaceous species that initiate flowering prior to June, but persist through summer months; **summer/fall forb** = herbaceous, initiate flowering in or after July; **warmgrass** = warm season grass, members of Poaceae, flowering in or after July; **woody** = perennial species with over wintering aboveground structures, includes trees, shrubs and woody vines; **succulents** = perennial succulent herbs, shrubs and small trees.

Scientific name	Common Name	Family	Guild
Acalypha ostryifolia	Rough-pod copperleaf	Euphorbiaceae	annual-biennial
Acalypha virginica	Virginia copperleaf	Euphorbiaceae	annual-biennial
Achillea millefolium	Common yarrow	Asteraceae	ephemeral
Agalinis aspera	Tall false foxglove	Scrophulariaceae	annual-biennial
Agalinis tenuifolia	Slenderleaf false foxglove	Scrophulariaceae	annual-biennial
Ageratina altissima	White snakeroot	Asteraceae	summer/fall forb
Agrostis hyemalis	Ticklegrass	Poaceae	coolgrass
Alliaria petiolata	Garlic-mustard	Brassicaceae	annual-biennial
Allium canadense	Onion	Liliaceae	spring forb
Alopecurus carolinianus	Carolina foxtail	Poaceae	coolgrass
Ambrosia psilostachya	Western ragweed	Asteraceae	summer/fall forb
Ambrosia trifida	Giant ragweed	Asteraceae	annual-biennial
Amorpha canescens	Lead-plant	Fabaceae	woody
Amphiachyris dracunculoides	Broomweed	Asteraceae	annual-biennial
Andropogon gerardii	Big bluestem	Poaceae	warmgrass
Androsace occidentalis	Western rockjasmine	Primulaceae	annual-biennial
Antennaria neglecta	Field pussytoes	Asteraceae	spring forb
Apocynum cannabinum	Hemp dogbane	Apocynaceae	spring forb

Scientific name	Common Name	Family	Guild
Arctium minus	Common burdock	Asteraceae	annual-biennial
Arenaria serpyllifolia	Thyme leaf sandwort	Caryophyllaceae	annual-biennial
Aristida oligantha	Prairie three-awn	Poaceae	warmgrass
Artemisia ludoviciana	White sage	Asteraceae	summer/fall forb
Asclepias stenophylla	Narrow-leaved milkweed	Asclepiadaceae	summer/fall forb
Asclepias syriaca	Common milkweed	Asclepiadaceae	spring forb
Asclepias tuberosa	Butterfly-weed	Asclepiadaceae	spring forb
Asclepias verticillata	Whorled milkweed	Asclepiadaceae	spring forb
Asclepias viridiflora	Green milkweed	Asclepiadaceae	summer/fall forb
Asclepias viridis	Ozark milkweed	Asclepiadaceae	spring forb
Aster drummondii	Hairy heart-leaved wild aster	Asteraceae	summer/fall forb
Aster ericoides	White heath aster	Asteraceae	summer/fall forb
Aster laevis	Smooth wild aster	Asteraceae	summer/fall forb
Aster oblongifolius	Aromatic wild aster	Asteraceae	summer/fall forb
Aster sericeus	Western silvery wild aster	Asteraceae	summer/fall forb
Astragalus canadensis	Canada milk-vetch	Fabaceae	legume
Astragalus crassicarpus	Ground-plum, prairie plum	Fabaceae	legume
Astragalus lotiflorus	Lotus milk-vetch	Fabaceae	legume
Baptisia australis	Blue wild indigo	Fabaceae	legume
Baptisia bracteata var. leucophaea	Plains wild indigo	Fabaceae	legume
Bouteloua curtipendula	Side-oats grama-grass	Poaceae	warmgrass
Bouteloua gracilis	Blue grama	Poaceae	warmgrass
Bouteloua hirsuta	Hairy grama-grass	Poaceae	warmgrass
Brickellia eupatorioides	False boneset	Asteraceae	summer/fall forb
Buchloe dactyloides	Buffalograss	Poaceae	coolgrass
Cacalia plantaginea	Tuberous Indian plantain	Asteraceae	summer/fall forb
Callirhoe alcaeoides	Pale poppy-mallow	Malvaceae	ephemeral
Calylophus serrulatus	Yellow sundrops	Onagraceae	spring forb
Capsella bursa-pastoris	Shepherd's purse	Brassicaceae	annual-biennial
Carex amphibola	Eastern narrowleaf sedge	Cyperaceae	grass-like

Scientific name	Common Name	Family	Guild
Carex blanda	Eastern woodland sedge	Cyperaceae	grass-like
Carex brevior	Shortbeak sedge	Cyperaceae	grass-like
Carex meadii	Mead's sedge	Cyperaceae	grass-like
Ceanothus americanus	New Jersey tea, redroot	Rhamnaceae	woody
Ceanothus herbaceus	Prairie-redroot	Rhamnaceae	woody
Cerastium brachypodum	Mouse-ear chickweed	Caryophyllaceae	annual-biennial
Chaerophyllum procumbens	Spreading chervil	Apiaceae	annual-biennial
Chamaesyce prostrata	Prostrate sandmat	Euphorbiaceae	annual-biennial
Chenopodium album	Lamb's quarters, pigweed	Chenopodiaceae	annual-biennial
Chenopodium berlandieri	Pitseed goosefoot	Chenopodiaceae	annual-biennial
Chloris verticillata	Windmill finger-grass	Poaceae	coolgrass
Cirsium altissimum	Tall thistle	Asteraceae	annual-biennial
Cirsium undulatum	Wavy-leaved thistle	Asteraceae	summer/fall forb
Clematis terniflora	Sweet autumn virgin's bower	Ranunculaceae	woody
Comandra umbellata	Bastard toad-flax	Santalaceae	spring forb
Convolvulus arvensis	Field-bindweed	Convolvulaceae	summer/fall forb
Conyza canadensis	Horseweed	Asteraceae	annual-biennial
Cornus drummondii	Rough-leaved dogwood	Cornaceae	woody
Corydalis micrantha	Slender corydalis	Fumariaceae	annual-biennial
Croton capitatus	Woolly croton	Euphorbiaceae	annual-biennial
Croton monanthogynus	Prairie-tea	Euphorbiaceae	annual-biennial
Cynanchum laeve	Honey vine	Asclepiadaceae	summer/fall forb
Cyperus esculentus	Chufa flatsedge	Cyperaceae	grass-like
Dalea aurea	Golden prairie clover	Fabaceae	legume
Dalea candida	White prairie clover	Fabaceae	legume
Dalea multiflora	Roundhead prairie clover	Fabaceae	legume
Dalea purpurea	Purple prairie clover	Fabaceae	legume
Delphinium carolinianum	Carolina larkspur	Ranunculaceae	spring forb
Delphinium carolinianum ssp. Virescens	Prairie larkspur	Ranunculaceae	spring forb
Descurainia pinnata	Tansy-mustard	Brassicaceae	annual-biennial
Desmanthus illinoensis	Bundleflower	Fabaceae	legume

Scientific name	Common Name	Family	Guild
Desmodium cuspidatum	Big tick-trefoil	Fabaceae	legume
Desmodium illinoense	Prairie tick-trefoil	Fabaceae	legume
Dichanthelium oligosanthes	Panic grass	Poaceae	coolgrass
Digitaria cognata	Carolina crab grass	Poaceae	coolgrass
Draba brachycarpa	Shortpod draba	Brassicaceae	annual-biennial
Draba cuneifolia	Wedgeleaf draba	Brassicaceae	annual-biennial
Draba reptans	Carolina draba	Brassicaceae	annual-biennial
Echinacea angustifolia	Prairie coneflower	Asteraceae	summer/fall forb
Eleocharis compressa	Spike-rush	Cyperaceae	grass-like
Ellisia nyctelea	Water-pod	Hydrophyllaceae	annual-biennial
Elymus canadensis	Canada wild rye	Poaceae	coolgrass
Eragrostis spectabilis	Purple lovegrass	Poaceae	warmgrass
Erigeron philadelphicus	Philadelphia daisy	Asteraceae	ephemeral
Erigeron strigosus	Rough fleabane	Asteraceae	annual-biennial
Erythronium mesochoreum	Midland fawnlily	Liliaceae	ephemeral
Escobaria missouriensis var. Missouriensis	Missouri foxtail cactus	Cactaceae	succulent
Eupatorium altissimum	Tall Joe-Pye weed	Asteraceae	summer/fall forb
Euphorbia corollata	Flowering spurge	Euphorbiaceae	summer/fall forb
Euphorbia dentata	Toothed spurge	Euphorbiaceae	annual-biennial
Euphorbia marginata	Snow-on-the-mountain	Euphorbiaceae	annual-biennial
Euphorbia spathulata	Prairie spurge	Euphorbiaceae	annual-biennial
Euthamia gymnospermoides	Great Plains flat-topped goldenrod	Asteraceae	summer/fall forb
Evolvulus nuttallianus	Shaggy dwarf morning-glory	Convolvulaceae	spring forb
Festuca subverticillata	Nodding fescue	Poaceae	coolgrass
Galium aparine	Cleavers	Rubiaceae	annual-biennial
Galium circaezans	Forest bedstraw, wild licorice	Rubiaceae	spring forb
Geranium carolinianum	Carolina crane's-bill	Geraniaceae	annual-biennial
Geum canadense	White avens	Rosaceae	spring forb
Grindelia squarrosa	Curly-top gum-weed	Asteraceae	annual-biennial

Scientific name	Common Name	Family	Guild
Hedeoma hispida	Rough false pennyroyal	Lamiaceae	annual-biennial
Hedyotis nigricans var. Nigricans	Diamondflowers	Rubiaceae	spring forb
Helianthus maximiliani	Maximilian sunflower	Asteraceae	summer/fall forb
Hieracium longipilum	Long-haired hawkweed	Asteraceae	summer/fall forb
Hordeum pusillum	Little barley	Poaceae	coolgrass
Hybanthus verticillatus	Nodding green violet	Violaceae	ephemeral
Hymenopappus scabiosaeus	Carolina woollywhite	Asteraceae	spring forb
Juncus interior	Inland rush	Juncaceae	grass-like
Kochia scoparia	Summer-cypress	Chenopodiaceae	annual-biennial
Koeleria macrantha	Junegrass	Poaceae	coolgrass
Krigia cespitosa	Weedy dwarfdandelion	Asteraceae	annual-biennial
Kummerowia stipulacea	Korean clover	Fabaceae	legume
Lactuca serriola	Prickly lettuce	Asteraceae	annual-biennial
Lamium amplexicaule	Henbit	Lamiaceae	annual-biennial
Laportea canadensis	Nettle	Urticaceae	summer/fall forb
Leersia oryziodes	Rice cut-grass	Poaceae	warmgrass
Lepidium campestre	Field-cress	Brassicaceae	annual-biennial
Lepidium densiflorum	Prairie-pepperweed	Brassicaceae	annual-biennial
Lespedeza capitata	Bush-clover	Fabaceae	legume
Lespedeza violacea	Violet lespedeza	Fabaceae	legume
Lespedeza virginica	Virginia lespedeza	Fabaceae	legume
Liatris aspera	Lacerate blazing star	Asteraceae	summer/fall forb
Liatris punctata	Blazing star, gay feather	Asteraceae	summer/fall forb
Linum sulcatum	Grooved yellow flax	Linaceae	annual-biennial
Lithospermum incisum	Narrow-leaved puccoon	Boraginaceae	spring forb
Lobelia cardinalis	Cardinal-flower	Campanulaceae	summer/fall forb
Lomatium foeniculaceum	Yellow wild parsley	Apiaceae	ephemeral
Malvastrum hispidum	Hispid false-mallow	Malvaceae	annual-biennial
Melilotus officinalis	Yellow sweet clover	Fabaceae	legume
Menispermum canadense	Moonseed	Menispermaceae	woody
Mirabilis nyctaginea	Heart-leaved umbrella-wort	Nyctaginaceae	spring forb

Scientific name	Common Name	Family	Guild
Monarda fistulosa	Wild bergamot	Lamiaceae	summer/fall forb
Muhlenbergia cuspidata	Plains muhly	Poaceae	coolgrass
Muhlenbergia frondosa	Wirestem muhly	Poaceae	warmgrass
Myosotis verna	Early scorpion grass	Boraginaceae	annual-biennial
Nothoscordum bivalve	Crowpoison	Liliaceae	ephemeral
Oenothera biennis	Common evening-primrose	Onagraceae	summer/fall forb
Oenothera macrocarpa	Wing-fruit evening-primrose	Onagraceae	spring forb
Oenothera speciosa	White evening-primrose	Onagraceae	spring forb
Onosmodium molle	Western false gromwell	Boraginaceae	spring forb
Opuntia macrorhiza	Plains prickly pear	Cactaceae	succulent
Oxalis dillenii	Southern yellow wood-sorrel	Oxalidaceae	spring forb
Oxalis violacea	Violet wood-sorrel	Oxalidaceae	spring forb
Panicum capillare	Witch-grass	Poaceae	warmgrass
Panicum virgatum	Switchgrass	Poaceae	warmgrass
Parthenocissus quinquefolia	Virginia-creeper, woodbine	Vitaceae	woody
Pascopyrum smithii	Western wheatgrass	Poaceae	coolgrass
Paspalum laeve	Field paspalum	Poaceae	warmgrass
Penstemon cobaea	Cobaea beardtongue	Scrophulariaceae	ephemeral
Penstemon tubiflorus	Tube beard-tongue	Scrophulariaceae	spring forb
Phlox divaricata	Forest phlox	Polemoniaceae	spring forb
Physalis heterophylla	Clammy ground cherry	Solanaceae	spring forb
Physalis longifolia	Longflower ground cherry	Solanaceae	spring forb
Physalis pumila	Prairie ground cherry	Solanaceae	spring forb
Physalis virginiana	Virginia ground cherry	Solanaceae	spring forb
Phytolacca americana	Pokeweed, pokeberry	Phytolaccaceae	summer/fall forb
Plantago patagonica	Wooly plantain	Plantaginaceae	annual-biennial
Plantago pusilla	Dwarf plantain	Plantaginaceae	spring forb
Plantago rhodosperma	Redseed plantain	Plantaginaceae	annual-biennial
Plantago rugelii	American plantain	Plantaginaceae	spring forb
Poa arida	Plains bluegrass	Poaceae	coolgrass

Scientific name	Common Name	Family	Guild
Poa pratensis	Kentucky bluegrass	Poaceae	coolgrass
Polygala verticillata	Whorled milkwort	Polygalaceae	annual-biennial
Polygonum virginianum	Jumpseed	Polygonaceae	summer/fall forb
Psoralea argophylla	Silvery scurf-pea	Fabaceae	legume
Psoralea esculenta	Breadroot scurf-pea	Fabaceae	legume
Psoralidium tenuiflorum	Gray scurf-pea	Fabaceae	legume
Ratibida columnifera	Columnar coneflower	Asteraceae	summer/fall forb
Rhus glabra	Smooth sumac	Anacardiaceae	woody
Ribes missouriense	Missouri gooseberry	Grossulariaceae	woody
Rosa arkansana	Dwarf prairie rose	Rosaceae	woody
Ruellia humilis	Fringeleaf ruellia	Acanthaceae	summer/fall forb
Ruellia strepens	Acanthus	Acanthaceae	summer/fall forb
Rumex crispus	Curly dock	Polygonaceae	spring forb
Salvia azurea	Sage	Lamiaceae	summer/fall forb
Sambucus canadensis	Common elder	Caprifoliaceae	woody
Schizachyrium scoparium	Little bluestem	Poaceae	warmgrass
Schrankia nuttallii	Sensitive brier	Fabaceae	legume
Scutellaria parvula	Little skullcap	Lamiaceae	spring forb
Senecio plattensis	Platte groundsel	Asteraceae	summer/fall forb
Setaria viridis	Green foxtail-grass	Poaceae	warmgrass
Sida spinosa	Prickly spinosa	Malvaceae	annual-biennial
Silene antirrhina	Catchfly, campion	Caryophyllaceae	annual-biennial
Silphium laciniatum	Compass-plant	Asteraceae	summer/fall forb
Sisyrinchium campestre	Blue-eyed grass	Iridaceae	ephemeral
Smilax tamnoides	Catbrier	Smilacaceae	woody
Solanum carolinense	Horse-nettle	Solanaceae	spring forb
Solanum rostratum	Buffalo-bur	Solanaceae	annual-biennial
Solidago canadensis	Common goldenrod	Asteraceae	summer/fall forb
Solidago canadensis var. Gilvocanescens	Common goldenrod	Asteraceae	summer/fall forb
Solidago missouriensis	Missouri goldenrod	Asteraceae	summer/fall forb
Solidago rigida	Stiff goldenrod	Asteraceae	summer/fall forb

Scientific name	Common Name	Family	Guild
Sorghastrum nutans	Indian grass	Poaceae	warmgrass
Spermolepis inermis	Red river scaleseed	Apiaceae	annual-biennial
Spiranthes cernua	Nodding ladies' tresses	Orchidaceae	summer/fall forb
Sporobolus asper	Tall dropseed	Poaceae	warmgrass
Sporobolus neglectus	Dropseed	Poaceae	warmgrass
Stellaria media	Common chickweed	Caryophyllaceae	annual-biennial
Strophostyles leiosperma	Small-flowered woolly bean	Fabaceae	legume
Symphoricarpos orbiculatus	Coralberry	Caprifoliaceae	woody
Taraxacum officinale	Common dandelion	Asteraceae	spring forb
Teucrium canadense	American germander	Lamiaceae	summer/fall forb
Thlaspi arvense	Field penny-cress	Brassicaceae	annual-biennial
Toxicodendron radicans	Common poison-ivy	Anacardiaceae	woody
Tradescantia bracteata	Sticky spiderwort	Commelinaceae	spring forb
Tradescantia ohiensis	Smooth spiderwort	Commelinaceae	spring forb
Trichostema brachiatum	Blue curls	Lamiaceae	annual-biennial
Tridens flavus	Purpletop	Poaceae	warmgrass
Triodanis leptocarpa	Narrow-leaved triodanis	Campanulaceae	annual-biennial
Triodanis perfoliata	Round-leaved triodanis	Campanulaceae	annual-biennial
Urtica dioica ssp. Gracilis	Nettle, stinging nettle	Urticaceae	summer/fall forb
Verbena simplex	Narrow-leaved vervain	Verbenaceae	spring forb
Verbena stricta	Hoary vervain	Verbenaceae	spring forb
Verbesina alternifolia	Wingstem	Asteraceae	summer/fall forb
Vernonia baldwinii	Western ironweed	Asteraceae	summer/fall forb
Veronica arvensis	Corn speedwell	Scrophulariaceae	annual-biennial
Veronica peregrina	Purslane speedwell	Scrophulariaceae	annual-biennial
Viola bicolor	Field pansy	Violaceae	annual-biennial
Viola pedatifida	Prairie violet	Violaceae	spring forb
Viola pratincola	Northern bog violet	Violaceae	ephemeral
Viola sororia	Common blue violet	Violaceae	spring forb
Vitis riparia	Frost grape	Vitaceae	woody
Vulpia octoflora	Six-weeks fescue	Poaceae	coolgrass

Scientific name	Common Name	Family	Guild
Xanthium strumarium	Common cocklebur	Asteraceae	annual-biennial
Zanthoxylum americanum	Common prickly ash	Rutaceae	woody
Zigadenus elegans	Death camas	Liliaceae	summer/fall forb
Zigadenus nuttallii	Nuttall's deathcamas	Liliaceae	spring forb
Zizia aurea	Common golden alexanders	Apiaceae	spring forb